Amendment to the Drawings

Please replace Drawing Sheets 1/10 to 10/10 (Figs. 1 to 13) currently on file with Replacement Sheets 1/10 to 10/10 (Figs. 1 to 13) being submitted, along with this paper.

REMARKS

Claims 1-16 are pending in the present Application and under examination. Claims 1 to 16 have been amended in order to more clearly define applicant's claimed invention and thereby overcome the outstanding Reasons for Rejection.

Replacement sheets of drawings (Figs. 1 to 13) in compliance with 37 CFR 1.121(d) are being submitted.

No new matter has been introduced by these amendments to claims and drawings.

Objection to the Drawings

In the outstanding Action, the drawings were objected to because it is impossible to make out the figures in the drawings.

In response, applicant is submitting Replacement Sheets of Drawings 1/10 to 10/10 (Figs. 1 to 13) in compliance with 37 CFR 1.121(d). Applicant respectfully requests the Examiner to reconsider the newly submitted drawings and withdraw this objection to the drawings.

Claim Rejections Under 35 U.S.C. §103

Claims 1 to 16 stand rejected under 35 U.S.C. §103(a) as being unpatentable over Baker et al. (US 2002/0054849), in view of Rodriguez, et al (US 5,653,951), Amundson, et al. (US 6,456,256), Resasco, et al. (US 6,333,016; hereinafter, Resasco-1) and Resasco, et al. (US 2002/0131910; hereinafter, Resasco-2).

In this application, Claims 1, 2, 9 and 10 are directed to a fibrous nanocarbon and all independent claims. Claims 3, 4, 11, 12 and 13 are directed to a preparation method of fibrous

nanocarbon (recited in the Claims 1, 2, 9 or 10). Claims 5 and 7, 6 and 8, 14, 15 and 16 are dependent from claims 3, 4, 11, 12 and 13 respectively.

In response, applicant has amended Claims 1 to 16 in order to more clearly define applicant's invention and/or further recite limitations to overcome the outstanding Reasons for Rejection.

Rejection of Claims Directed To Fibrous Nanocarbon

On pages 6 through 10 of the Action, the Examiner has rejected Claims 1, 2, 9 and 10 (directed to a fibrous nanocarbon) under 35 U.S.C. §103(a) as being unpatentable over Baker, in view of Rodriguez, Amundson and Resasco-1.

Applicant's fibrous nanocarbon claimed in Claims 1, 2, 9 and 10 is different from those disclosed in the cited prior art references, in respect of their fundamental structures. That is, applicant's fibrous nanocarbon features, among others, a *pair-structure formed of two unit fibrous nanocarbon, which are independently grown along two independent growth axes*. The two independently grown fibers form *the pair structure as a single body*, as is shown in modeled diagrams of Figs. 4 and 13. Further, Figs. 8 and 9A of this application are SEM and TEM photographs respectively for applicant's pair-structured fibrous nanocarbons obtained in Example 3 of this application. It is clearly evident from Figs. 8 and 9A that applicant's carbon nanofiber has a *pair-structure formed of two directional unit fibers, which are independently grown along two-independent axes*.

Furthermore, as is shown in a structural model of Fig. 4, the two nanofibers are *connected to each other by means of knots (nodes) formed at intervals along the directional growth axis, thereby forming a ladder-like structure and providing open parts (openings) between the knots (nodes)*. Thus, the inner side of the hollow fiber is open to the outside. Figs. 2a and 3a are TEM photographs for applicant's ladder-structured fibrous nanocarbon. It is clearly seen from Figs. 2a and 3a that applicant's pair-structured fibrous nanocarbon has knots (or nodes) along its axis and open parts (openings) in-between, thereby in general forming a ladder-like fiber structure.

However, as shown in Figs. 5 and 6, prior art fibrous nanocarbon exhibits a clean surface and thus does not provide a pair or ladder structure, as explained in lines 7 to 12 on page 13 of this application.

Applicant respectfully submits that applicant's claimed fibrous nanocarbon is different from those disclosed in the prior art references, in terms of their basic structures, let alone their physical properties such as the spacing and inclination angles. These features of applicant's invention are recited in Claims 1, 2, 9 and 10 currently amended, as follows.

> "**Claim 1**. A fibrous nanocarbon characterized by carbon hexagonal plane or stacking thereof, *having two directional growth axis to grow two units of carbon nanofibers,* whereby; (1) the sp^2hybrid carbon content of more than 95% per total content; (2) the interlayer spacing d_{002}, d-spacing of C(002) profiles determined by X-ray diffraction method) of 0.3360 nm to 0.3800 nm; (3) the (002) plane stacking of more than 4 layers and the aspect ratio of more than 20; (4) the fiber cross-section width/thickness of 2.0 nm to 800 nm; (5) the inclination angle of hexagonal plane alignment for each composed carbon nanofibers to the fiber axis of 0 to 85 degrees; and carbon hexagonal planes stacking along the fiber axis, *forming knots (nodes) at intervals of 5 nm to 100 nm, sharing partly the structure or stacking layers in carbon hexagonal planes of each composed carbon nanofibers and connecting periodically to each other, consequently forming ladder-like structure with open parts between each connection units, through which the inner side of the fibrous nanocarbon is open and connected to the outer space,*
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> wherein the carbon hexagonal planes align angled to the fibrous nanocarbon axis, and the two unit carbon nanofibers are combined by inter-fiber force or van der walls force, *forming pair structure as a single body*." (Emphasis added)

> "**Claim 2.** A fibrous nanocarbon characterized by carbon hexagonal plane or stacking thereof, *having two directional growth axis to grow two units of carbon nanofibers,* whereby; (1) the sp^2 hybrid carbon content of more than 95% per total content; (2) the interlayer spacing d_{002}, d-spacing of C(002) profiles determined by X-ray diffraction method) of 0.3360 nm to 0.3800 nm; (3) the (002) plane stacking of more than 8 layers; (4) the width/thickness of fiber cross-section of 2.0 nm to 800 nm; (5) the aspect ratio is more than 20; and (6) *bonding of two unit carbon nanofibers with said (1) to (5) features at 0.5 nm~30 nm distance by the inter-fiber force between the two unit fibers from the beginning of fiber formation*,
>
> wherein the carbon hexagonal planes align angled to the fibrous nanocarbon axis, and *the two unit carbon nanofibers are combined by inter-fiber force or van der walls force, forming pair structure as a single body.*" (Emphasis added)

> "**Claim 9.** A fibrous nanocarbon characterized by carbon hexagonal plane or stacking thereof, *having two directional growth axis to grow two units of carbon nanofibers*, whereby; (1) more than 95 wt % of carbon content; (2) 5.5 [[~]]to 550 nm fiber diameters; (3) the aspect ratio of more than 10; and (4) carbon hexagonal planes stacking along the fiber axis, *forming knots at regular intervals sharing partly the structure or stacking layers in carbon hexagonal planes of each composed carbon nanofibers and connecting periodically to each other, forming open parts between each connection units through which the inner side of the fibrous nanocarbonis open and connected to the outer space* with no continuous hollow core in the inner space of said fibrous nanocarbon,
>
> wherein the carbon hexagonal planes align angled to the fibrous nanocarbon axis, and *the two unit carbon nanofibers are combined by inter-fiber force or van der walls force, forming pair structure as a single body*." (Emphasis added)

> "**Claim 10.** A fibrous nanocarbon characterized by carbon hexagonal plane or stacking thereof, *having two directional growth axis to grow two units of carbon nanofibers*, whereby; (1) more than 95 wt % of carbon content; (2) 5.5 to 550 nm fiber diameters; (3) the aspect ratio of more than 10, and *bonding of two unit carbon nanofibers* with no continuous hollow core in the inner space of said fibrous nanocarbon,
>
> wherein the carbon hexagonal planes align angled to the fibrous nanocarbon axis, and *the two unit carbon nanofibers are combined by inter-fiber force or van der walls force, forming pair structure as a single body.*" (Emphasis added)

Baker is directed to a process for producing crystalline carbon nanofibers where the graphite sheets are grown in parallel to the longitudinal axis of the fiber. However, Baker is totally silent about applicant's pair-structure formed of two unit fibers and ladder-structure having knots and open parts. Similarly, Resasco-1 is directed to a method of producing carbon nanotube by contacting gas with metallic catalytic particles. Resasco-1 discloses optimization for process conditions throughout the entire patent, but not teaches or suggests the structural features of applicant's claimed fibrous nanocarbon. Amundson discloses implantable medical devises and fails to teach or suggest applicant's pair-structured or ladder-structured carbon nanofiber having open parts.

Thus, applicant believes that Baker, Rescaso-1 and Amundson, alone or in combination, *fail to teach or suggest the structural features of applicant's invention* claimed in Claims 1, 2, 9 and 10 currently amended. Accordingly, *prime facie* obviousness does not exist regarding

amended Claims 1, 2, 9 and 10 with respect to Baker, Rescaso-1 and Amundson. Applicant respectfully submits that currently amended Claims 1, 2, 9 and 10 are now to be allowed.

Rejection of Claims Directed to Preparation method

On pages 4 to 6 of the Action, the Examiner has rejected Claims 3 to 8, 11 to 16 (directed to a preparation method of fibrous nanocarbon) under 35 U.S.C. §103(a) as being unpatentable over Baker, in view of Resasco-2 and common knowledge in the art.

In this regard, applicant has amended Claims 3 to 8, 11 to 16 in order to more clearly define applicant's invention and/or further recite limitations to overcome the outstanding Reasons for Rejection. Newly added limitations are fully supported by the originally filed specification, for example, from line 2 on page 15 to line 12 on page 16 of this application.

Claims 3, 4, 11, 12 and 13 currently amended recite the following limitations.

> "*the catalyst is prepared by the steps comprising of: preparing an alloy of primary metal and secondary metal; reducing the alloy to form an alloy-catalyst; cooling the alloy-catalyst for passivation; reducing the cooled alloy-catalyst at the temperature ranges of 450~550℃ under the hydrogen-helium mixed gases containing 1~40v/v % hydrogen; and reacting the reduced alloy-catalyst with the gaseous or liquid carbon sources.*

As can be seen from the above limitations, applicant's method features, among others, using a catalyst, which is especially prepared through *two-step reduction process*. As explained in line 2 on page 15 through line 12 on page 16 of this application, applicant's alloy catalyst is primary reduced under a mixed gas of hydrogen and helium at a temperature of 450~550°C for 0.5 to 40 hours. Then, after passivation, the alloy catalyst is secondary reduced under a mixed gas of hydrogen and helium at a temperature of 450~550°C for 0.5 to 12 hours. This is of value to improve the activity of a catalyst by exposing the active surface of metallic catalysts.

In contrast, Baker is silent about applicant's alloy catalyst and its preparation method. As clearly described in paragraph [0023] of Baker, Baker's catalyst is prepared through co-precipitation of aqueous solution containing iron, nickel and copper nitrates using ammonium

bicarbonate. Then, the precipitates were dried at about 110°C and calcined in air at 400°C to convert the carbonates into mixed metal oxides. Thereafter, the calcined powders are reduced in hydrogen for 20 hours at 400°C. The reduced catalyst is cooled to room temperature and passivated in an oxygen/helium mixture at room temperature. Therefore, Baker fails to disclose a secondary reduction of catalyst after passivation. Rescasco-2 discloses using iron in combination with other metals, but does not teach or suggest applicant's two-step reduction process of an alloy catalyst.

Thus, applicant believes that Baker and Resasco-2, alone or in combination *fail to teach or suggest the two-step reduction of applicant's invention* claimed in 3, 4, 11, 12 and 13 currently amended. Accordingly, *prime facie* obviousness does not exist regarding amended Claims 3, 4, 11, 12 and 13 with respect to Baker, Resasco and common knowledge in the art. Applicant respectfully submits that currently amended Claims 3, 4, 11, 12 and 13 are now to be allowed. Claims 5 and 7, 6 and 8, 14, 15, and 16 are also believed to be allowable, by virtue of their dependencies from Claim 3, 4, 11, 12, and 13 respectively.

Conclusion

In view of the foregoing, it is respectfully submitted that the instant application is in condition for allowance. No new matter is added by way of the present Amendments and Remarks, as support is found throughout the original filed specification, claims and drawings. Reconsideration and subsequent allowance of this application are courteously requested.

Applicant hereby petitions for any necessary extension of time required under 37 C.F.R. 1.136(a) or 1.136(b) which may be required for entry and consideration of the present Reply.

If there are any charges due with respect to this Amendment or otherwise, please charge them to Deposit Account No. 06-1130 maintained by Applicant's attorneys.

Respectfully submitted,

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